Distributed Energy Resources Combined Heat and Power Workshop

Virginia Department of Environmental Quality

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March 4, 2003

Agenda

- Distributed Generation Technologies
  - Reciprocating Engines
  - Microturbines
  - Photovoltaic
  - Wind
- Who are the players?
- Value Proposition

Who are the players?

- Reciprocating Engines
  - Caterpillar
  - Cummins
  - Generac
  - Coast Intelligen
  - Hess Microgen
  - Teco Gen

Caterpillar teams with Active Power to provide UPS with the addition of a flywheel.

Cummins and Capstone Microturbines form a new line of power generation equipment by Cummins - "Powered by Capstone".

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Coast Intelligen - German MAN engine, high system efficiency, proprietary heat recovery package, excellent service & maintenance intervals.

Hess Microgen - multiple sizes, high efficiency, CHP systems, substantial resources support product.

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Generac - DG50 - 50kW gas reciprocating engine, simple design and installation.

TECO Gen - long history in cogen, limited sizes, good reputation, work with chillers (TECOChill) also.

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Who are the players?

- Microturbines
  - Capstone
  - Ingersoll-Rand
  - Turbec
  - Elliot Energy Systems
  - Bowman
  - Kawasaki

Capstone 30 and 60 kW systems. Air bearings, single shaft, "household name" in microturbines

Ingersoll-Rand Energy Systems, PowerWorks® dual shaft, industrial pedigree, 70 kW and 250 kW with heat recovery integral to unit.

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Turbec - Joint venture of Volvo Aero and ABB. 100 kW system testing in Europe, opened US operations summer 2001

Elliott provides microturbines to Bowman, multiple sizes, portable power

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Who are the players?

- Fuel Cells
  - UTC Fuel Cells (ONSI)
  - Fuel Cell Energy
  - Siemens Westinghouse
  - Ballard
  - Plug Power

UTC Fuel Cells (United Technologies, ONSI), phosphoric acid, mature technology, commercially available, moving to PEM

Fuel Cell Energy - molten carbonate, MW size, commercial applications in process, stationary power.

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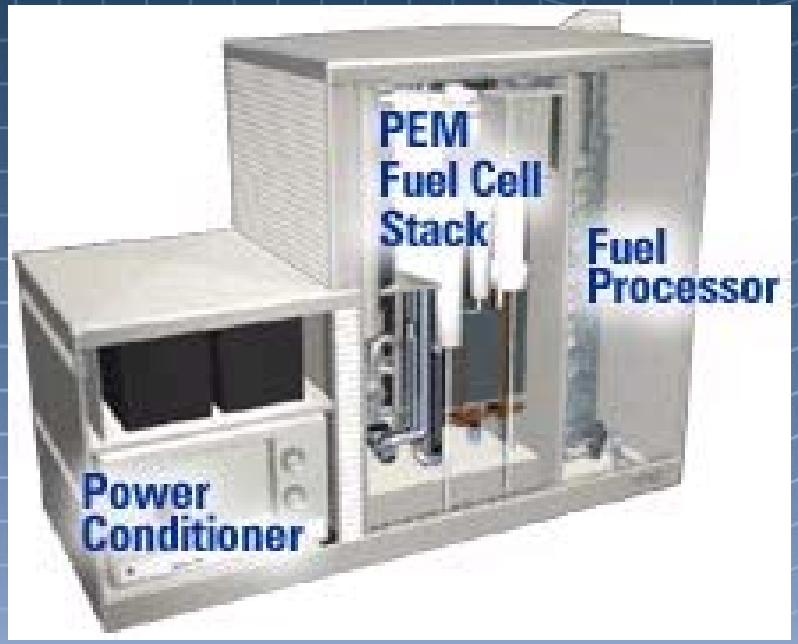
Ballard - PEM - heavy investment from transportation industry (GM, Ford, DiamlerChrysler), stationary power.

Plug Power - PEM - residential applications, partnership with GE.



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Siemans-Westinghouse - solid oxide - working on hybrid systems, equipment problems with high operating temperatures.

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Who are the players?

- Photovoltaic
  - Astropower
  - EPV
  - Energy Conversion Devices
  - Kyocera Solar
  - Siemens Solar
  - SunPower Corp.

Photovoltaics

- Regional opportunities
  - Best US locations - Southwest
  - 1 MW in New Jersey requires approximately 1 square mile
- Technology evolving
- Expensive
- Excellent application for "net metering"

Who are the players?

- Wind
  - Manufacturers
    - The Wind Turbine Company
    - Bergy Windpower
    - Mitsubishi
  - Developers
    - AEP Energy Services
    - FPL Energy

Wind

- Regional opportunities
  - Best US locations - West (California)
  - Projects in PA and upper Midwest
- Technology evolving
- Expensive
- Sitting issues

Value Proposition

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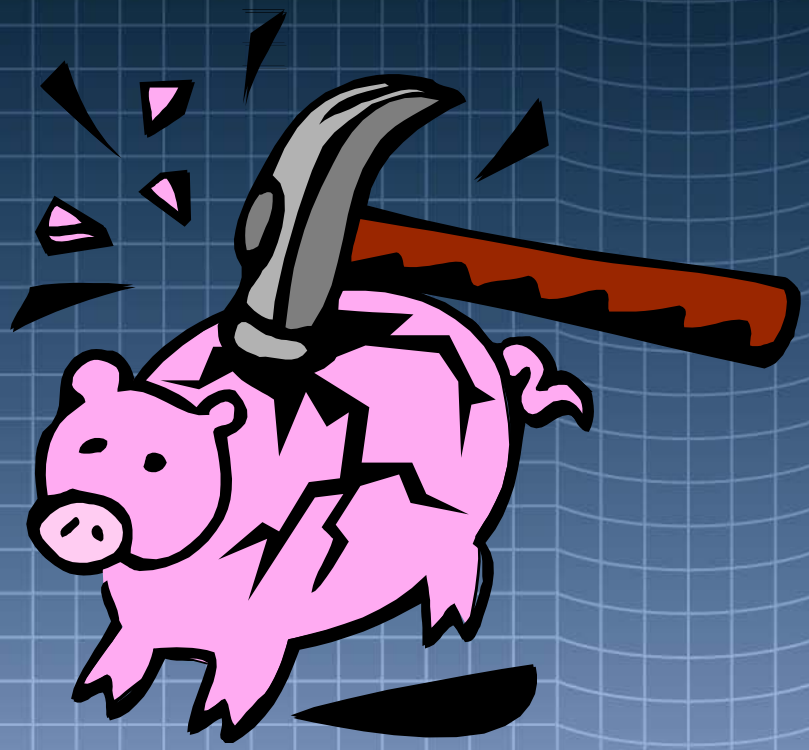
Customer Perspectives

- Return on Investment (ROI)
- Simple Payback
- Immediate Cost Savings
- Financing
  - On Balance Sheet
  - Off Balance Sheet
- Own/Operate
- Purchase energy



Cost to Generate

Fuel Cost v Equipment Efficiency

Generator Efficiency	Fuel Price ($/MMBtu) (no heat recovery)				
	$5.00	$6.00	$7.00	$8.00	$9.00
20%	$0.0854	$0.1024	$0.1195	$0.1366	$0.1536
25%	$0.0683	$0.0819	$0.0956	$0.1092	$0.1229
30%	$0.0569	$0.0683	$0.0797	$0.0910	$0.1024
35%	$0.0488	$0.0585	$0.0683	$0.0780	$0.0878

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Technology Comparison
Costs & Efficiency

	Gas Recip	MT	Fuel Cell	PV	Wind
Capacity	50 kW - 5 MW	30 kW - 100 kW	50 kW - 2 MW	1 kW - 1 MW	10 kW - 1 MW
Efficiency - lhv [1]	35%	21% - 32%	40% - 57%	6% - 19%	25%
Equipment $/kW[2]	$500 - $700	$1000 - $1,300	$4,500 - ? [4]	$3,000 - $5,000	$600 [5]
Installation $/kW	$200 - $300	$250 - $500	+/-$1,000	$3,000	$400 [5]
O&M $/kW [3]	$0.01	$0.011	$0.002 [6]	$0.001 - $0.004	$0.01

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Technology Comparison
Costs & Efficiency

- Notes for previous chart
  - (1) Efficiencies of renewable energy technologies, PV and Wind, should not be compared directly with those of fossil technologies, since there is no fuel "cost".
  - (2) This is the cost for the equipment and does not include the cost of engineering, installation, etc.
  - (3) O&M excludes fuel cost. There are no fuel costs for wind or PV systems but relative fuel costs should be considered in evaluation of fossil technologies.
  - (4) Before any grants or subsidies.
  - (5) Estimated from equipment costs.
  - (6) Does not include cost for replacement fuel cell stack.

Final Comments

- Distributed Generation is here to stay - regardless of the technology.
- Incentives and subsidies will expedite the deployment and perfection of the all DG technologies.
- As DG becomes more widely deployed, the costs *will* be reduced.

What can Virginia do to help?

- Favorable tariff structures
  - DG tariff for gas
- Incentives
  - Assistance in installation (meters, infrastructure, etc.)
  - $$$
- Simplify Interconnect
  - Standards (IEEE 1547, CA Rule 21, NY SIR)
  - Inexpensive
- Go beyond testing and R & D
  - Install units at "YOUR" facilities

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Market Leading Brands

Climate Control

Thermo King, Hussmann

Infrastructure

Ingersoll-Rand, Bobcat, Blaw-Knox, Club Car

Industrial Solutions

ARO, IR ASG, Energy Systems

Security and Safety

Schlage, Von Duprin, Steelcraft, Kryptonite

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